Studies of Pollution in the Indian River Complex

T. A. Nevin and J. A. Lasater

The Indian River-Banana River Complex is an estuarine lagoon, which serves as a major recreational area of the Central East Coast of Florida. Permanent populations along its shores vary considerably, from essentially rural to small city densities. In general, the more urban areas are served by conventional sewage Western Shore. The rest of the area is serviced by septic tanks. treatment plants, the more important of which are located on the There is also a thriving shell-fish industry in the area.

Since pollution of these waters is of economic as well as esthetic importance, studies of the nature and levels of certain pollutants were initiated.

Methods and Materials

Two sample lines have been established in the Indian River, between the Eau Gallie and Melbourne Causeways. Each line is anchored on the Coast and Geodetic Survey buoys which mark the channel for the Intracoastal Waterway, and with easily recognized landmarks on either shore. Specific sampling points along each line were selected by triangulation, and marked with appropriately identified buoys.

Samples of the river bottom were obtained with a "tiltcan", devised by a student assistant, and stored in plastic bags. Water samples were collected in clean plastic 1-2 gallon bottles. All samples were stored under refrigeration until analyzed. Bacteriological analyses were begun within 3 to 4 hours after sample collection; chemical analyses, within 24 hours.

Ten grams wet weight of bottom sample were shaken vigorously in 90 ml of sterile distilled water for 10 minutes. The heavy particulates were allowed to settle and the fluid portion then used for bacterio-logical evaluation. The remainder of the sample was dried at 70-80 C for 24 hours. The dried sample was then extracted with 10 times its weight of distilled water. The aqueous exact was used for chemical analyses. All data, bacteriological as well as chemical, from bottom samples, are presented as amounts per gram of dried sample.

River water samples were suitably diluted with sterile distilled water for bacteriological evaluation, and as necessary for chemical analyses.

Bacterial analysis employed the millipore-filter technique (Fifield and Schaufus, C. P. 1958). Nitrate was reduced to nitrite with cadmium and reacted with alpha naphthol. Lignin-tannin (hydroxylated aromatic compounds) was estimated by reaction with tyrosine (Hach, 1969), and phenol with 4-aminoantipyrine and extraction with chloroform (Standard Methods, APHA 1965). Chloride was titrated with silver nitrate (Standard Methods, APHA 1965), and pH was measured potentiometrically.

EXPERIMENTAL

Preliminary experiments, as exemplified in Table 1, indicated that variations in the distribution of the river contents measured, might be of some significance. For example, the nitrate concentration increased from 22 μg/ml on the west bank to 26.4 μg/ml on the east bank. A similar increase occurred from surface waters

TABLE 1

Cross-sectional distribution of nitrate[1] and coliforms[2] in the Indian River

Depth	Sample Points				
	1	2	3	4	5
Surface					
NO_3	22.00	22.44	22.88	25.08	26.4
Coliforms	0	170	988	64	0
3 Feet					
NO_3	27.28	24.64	28.16	28.60	28.38
Coliforms	304	0	810	182	79
6 Feet					
NO_3		22.44	33.00	31.24	
Coliforms		0	0	461	
13 Feet					
NO_3			33.00		
Coliforms			0		

[1]Micrograms per milliter.
[2]Per 100 milliliters of sample.

to near bottom waters, ranging from an average of 24 μg/ml at the surface to 33 μg/ml at 13 feet deep (just above the bottom). Of interest also is the distribution of coliforms among the samples. These seemed not to occur consistently below a depth of 3 feet.

It was decided therefore, that several factors should be studied in detail, and that initial experiments would be concerned with comparisons of the levels of these factors in surface waters with those in bottom samples taken from the sampling point. Table 2 summarizes these initial experiments. It should be noted that the data presented Table 1 were obtained from samples collected during February 1969, a relatively dry period, whereas those in Table 2 were obtained from samples collected during April and May 1969, when rain occurred fairly frequently.

The concentration of nitrate was about 4 times greater in bottom samples than in surface water samples, in agreement with the vertical distribution data for this pollutant as shown in Table 1. The unexpectedly high levels demonstrable in bottom samples may reflect the formation of some colloidal CdS during testing but this was not visible to the unaided eye. Alternatively, there may have been some nonspecific absorption of nitrate which carried it to the bottom. The west to east increase noted previously (Table 1) does not appear in Table 2, probably because of the wind and wave mixing action during rainstorms.

The distribution of chloride ions was also unexpected, and is not amenable to easy explanation. Pending further study, it is suggested that this may indicate the intrusion of ocean waters into the lagoon, probably through Sebastian Inlet.

The fate of the wood extractives lignin and tannin is not well understood. The present data suggest that these materials may accumulate on the bottom of the river, and are there degraded, probably by biological action. The high levels in bottom samples, about 10 times the concentrations found in surface waters, may also be amenable to explanation by absorption. Another possible explanation, which would apply to nitrates as well, is the relatively higher pH of the bottom and this could cause the bottom to serve as an anion trap. In this connection, it is interesting to point out that at the lower pH of the surface waters appreciably fewer coliform bacteria occurred than in the bottom samples

TABLE 2

Distribution of certain common materials between surface water and dried river bottom samples

Sample Point		1	2	3	4	5	6	Average-10 Tests
Nitrate	Surface	27.5	27.5	25.3	22.0	29.7	23.1	25.85
	bottom	79.2	—	110.2	145.2	88.0	162.8	117.10
Chloride	Surface	112.5	127.25	107.5	117.5	119.5	106.25	115.23
	bottom	37.5	—	57.5	27.5	27.5	32.5	36.5
Lignin	Surface	0.375	0.23	0.175	0.125	0.415	0.175	0.268
Tannin	bottom	40.00	—	16.00	26.00	16.00	20.00	23.60
Phenol	Surface	0.098	0.121	0.120	0.072	0.095	0.127	0.106
	bottom	0.090	—	0.140	0.130	0.130	0.130	0.124
pH	Surface	6.65	6.90	6.80	6.50	6.55	6.55	6.66
	bottom	7.60	7.90	7.60	7.70	7.60	7.50	7.65
Coliforms[2]	Surface	5500	10,100	7400	6400	9400	8800	7900
	bottom	TNTC[3]	TNTC	TNTC	TNTC	TNTC	TNTC	TNTC

[1]For purposes of this publication it has been assumed that 1mL of water and 1 gram, dry weight, of bottom material are equivalent.

[2]Includes all gram negative, lactose fermenting, rod-shaped bacteria which grow on Endo's medium.

[3]Too numerous to count.

at the higher pH.

The fact that phenol seemed to be fairly evenly dispersed between the surface water and the bottom, while inexplicable at present, tends to validate the data for the other components measured. If there were a sampling bias toward increased values in bottom specimens, it should have been reflected in the phenol levels.

ACKNOWLEDGMENT

The authors take this opportunity to thank the students of the Hydrospace Technical Institute, who collected the samples and conducted most of the tests herein reported, and to thank Mr. Sheldon Hall, the Director of HTI, for his cooperation.

LITERATURE CITED

FIFIELD, C. W., AND SCHAUFUS, C. P. 1958. Improved membrane filter medium for the detection of coliform organisms. Jour. Amer. Water Works Assn., vol. 50, pp. 193-6.

AMERICAN PUBLIC HEALTH ASSOCIATION. 1965. Standard methods for the examination of water and waste water. American Health Association, American Water Works Association, & Water Pollution Control Federation, 12th ed., p. 769.

HACH CHEMICAL COMPANY. 1967. Water and waste water analysis procedures. Hach Chemical Company, Ames. Iowa, p. 104.

University Center for Pollution Research, Florida Institute of Technology, Melbourne, Florida.

Quart. Jour. Florida Acad. Sci. 32 (3) 1969 (1970)